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Asymmetric impacts on Mars' polar vortices from the 2018 Global Dust Storm



Paul Streeter¹ (paul.streeter@open.ac.uk),

Stephen Lewis¹, Manish Patel^{1,2}, James Holmes¹,
Anna Fedorova³, David Kass⁴, Armin Kleinböhl⁴

¹School of Physical Sciences, The Open University, UK

²Space Science and Technology Department, Rutherford Appleton Laboratory, UK

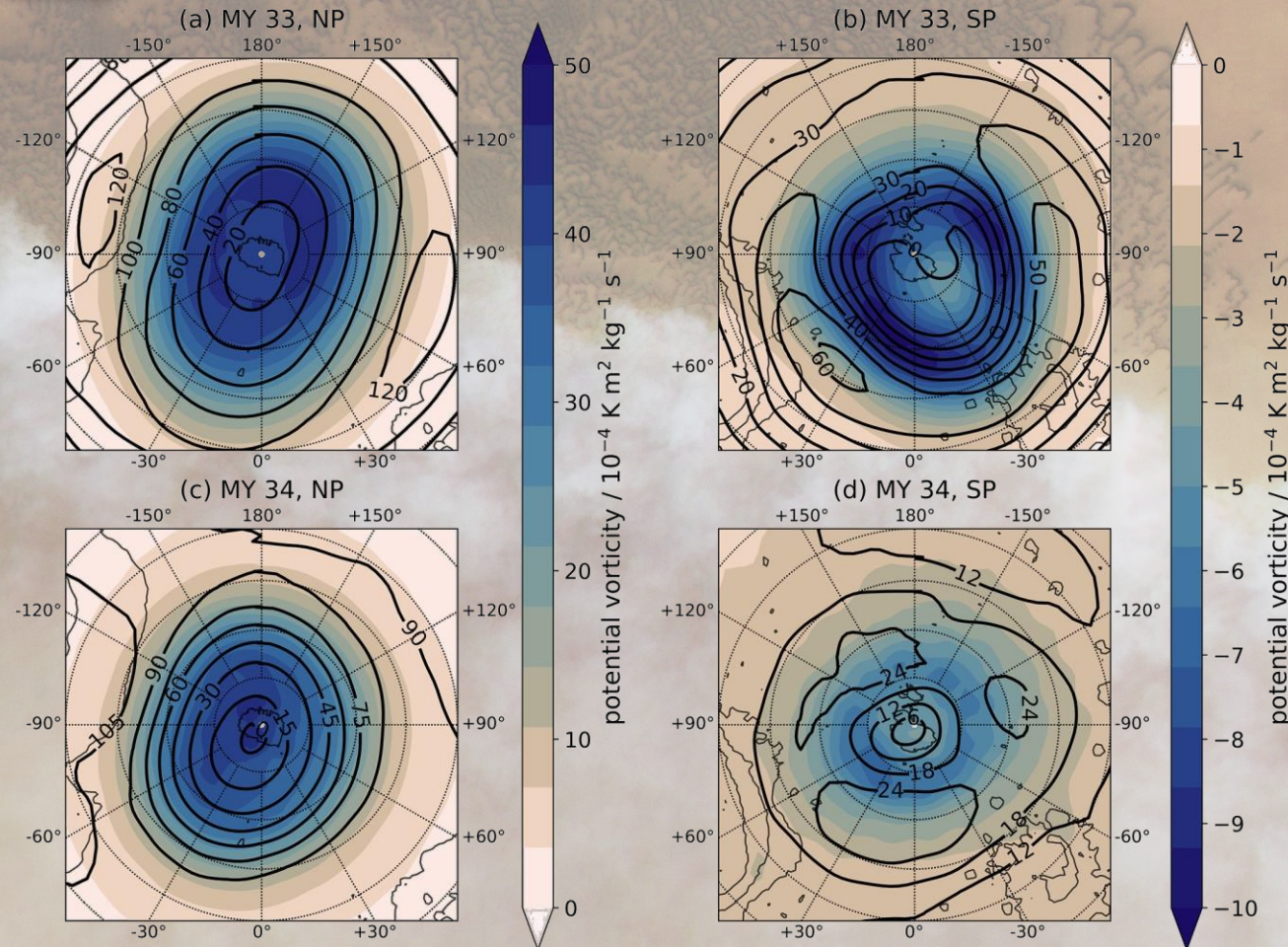
³Space Research Institute of the Russian Academy of Sciences (IKI RAS), Moscow, Russia

⁴Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA, USA

The 2018 Global Dust Storm had significant and asymmetrical impacts on the morphology and intensity of Mars' two polar vortices

The southern vortex was substantially diminished while the northern vortex remained robust, but both were reduced in ellipticity

These vortex changes enhance transport into Mars' southern (but not northern) polar region and modify longitudinal transport patterns

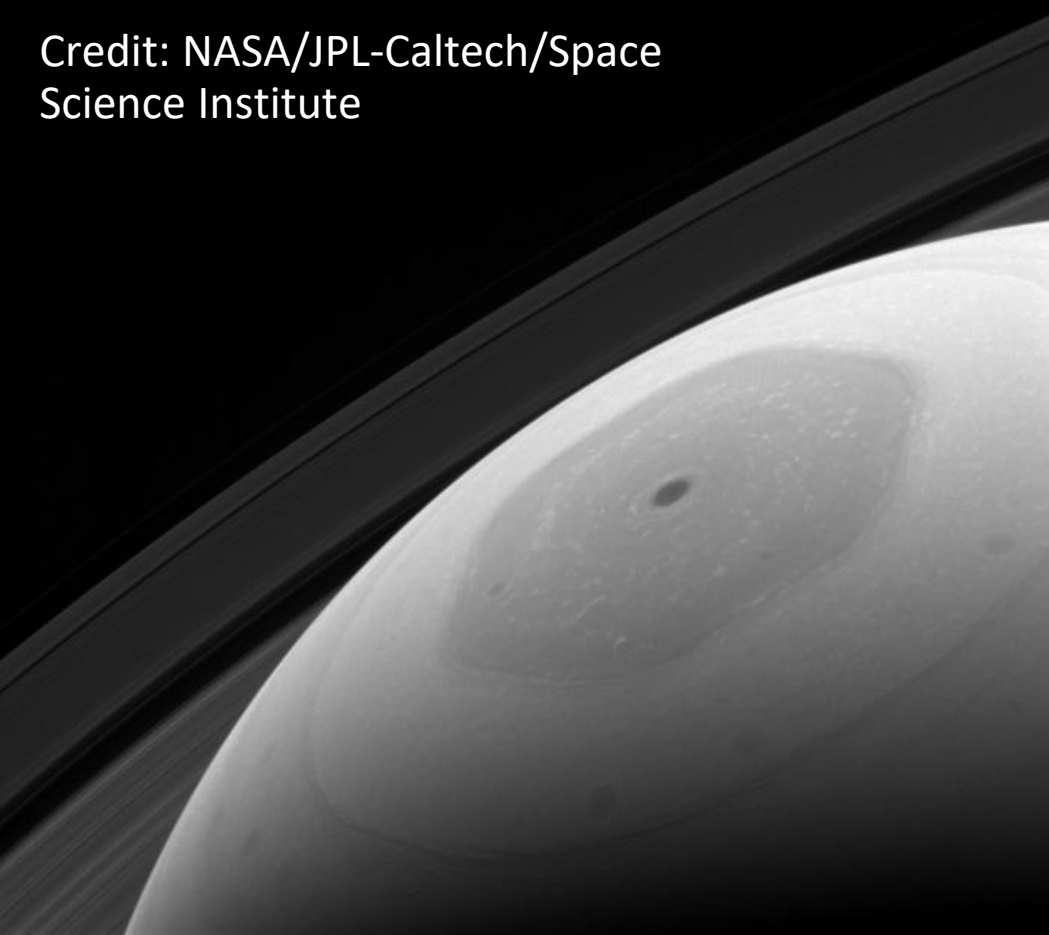



PAPER LINK

Streeter, P. M., Lewis, S. R., Patel, M. R., Holmes, J. A., Fedorova, A. A., Kass, D. M., & Kleinböhl, A. (2021). **Asymmetric impacts on Mars' polar vortices from an equinoctial global dust storm.** *Journal of Geophysical Research: Planets*, 126, e2020JE006774

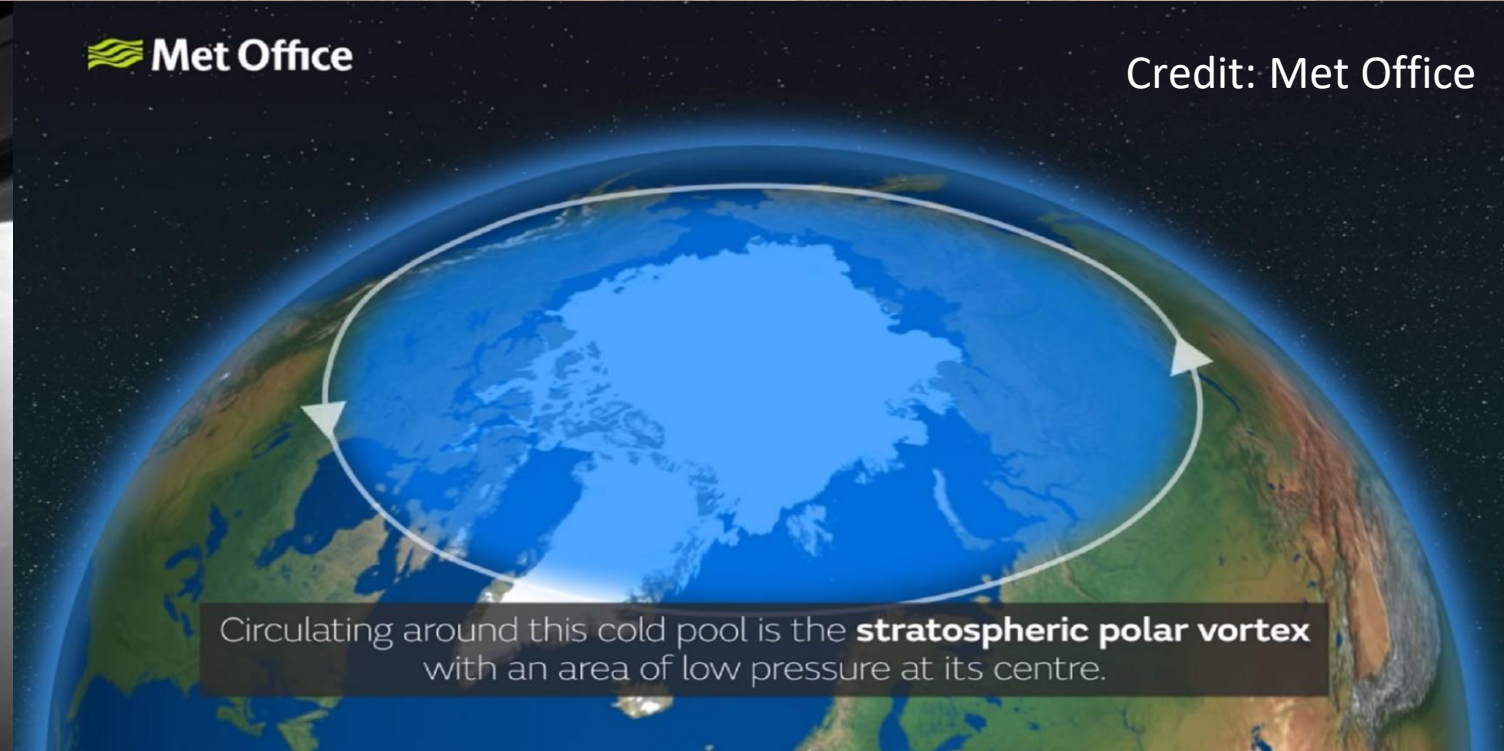
Polar vortices

Credit: NASA/JPL-Caltech/Space
Science Institute



 Met Office

Credit: Met Office

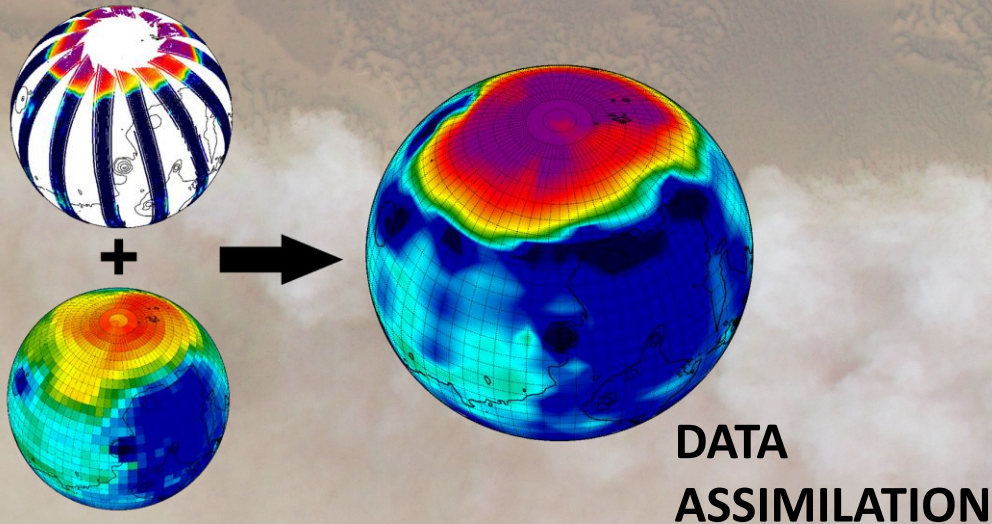


Circulating around this cold pool is the **stratospheric polar vortex** with an area of low pressure at its centre.

- Common feature of planetary atmospheres
- Regions of cold, isolated air over winter pole circumscribed by powerful westerly wind jet
- Mars has characteristically elliptical vortices

Methods

OBSERVATIONS: Mars
Climate Sounder
(MRO/MCS) + Atmospheric
Chemistry Suite (TGO/ACS)



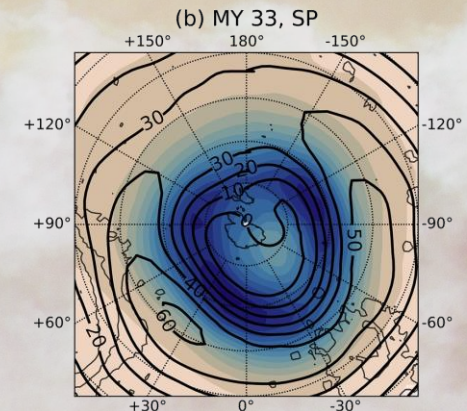
MODEL: Mars Global
Climate Model (MGCM)

2018 GLOBAL DUST STORM

- Mars Year (MY) 34
- Latitudinal extent: ~40 N to ~60 S
- Lasted several months
- Occurred at Mars equinox (transition from southern autumn/winter to southern spring/summer)
- Compared to MY 33, a “typical” year on Mars (no Global Dust Storm)

POTENTIAL VORTICITY (PV)

- Conserved dynamical/thermodynamic quantity
- Useful tracer for polar vortex location and intensity
- Greater value → more intense polar vortex

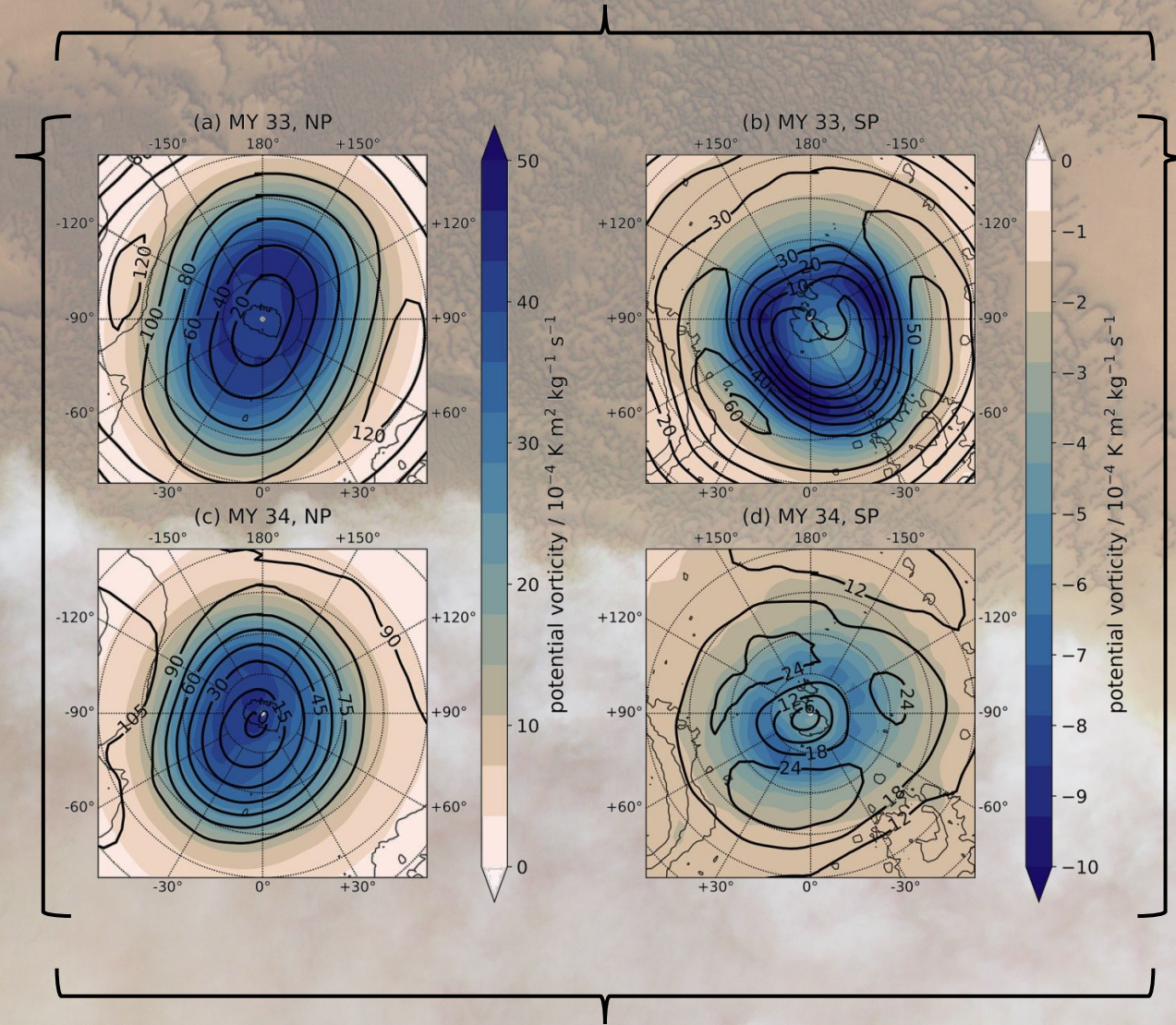


What?

Clear

North

- More symmetrical polar vortex shape; non-elliptical
- Reduced area
- Similar intensity
- Narrowed westerly jet



South

- More symmetrical polar vortex shape; non-elliptical
- Substantial local reduction in potential vorticity
- Significantly weakened winds

Why?

Storm

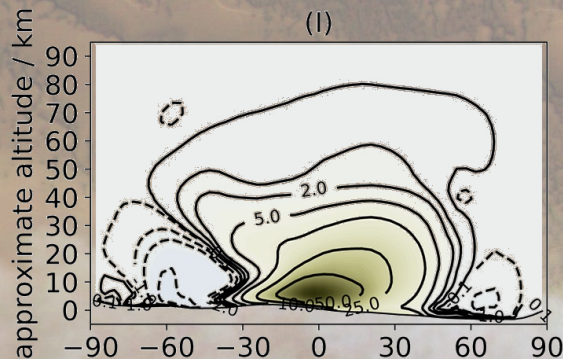
Why?

Why?

North

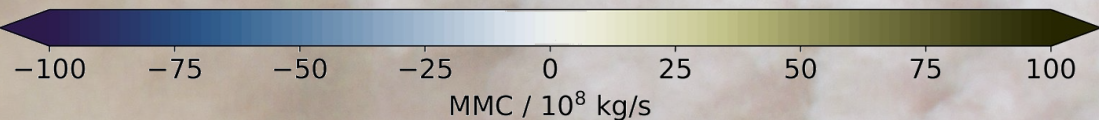
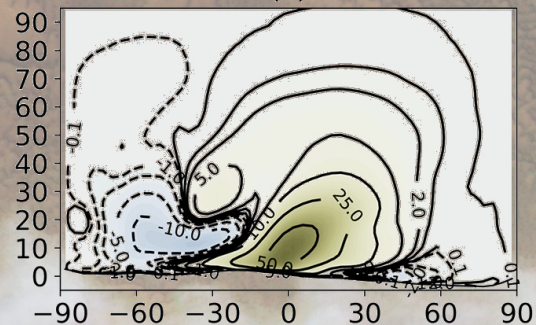
MY 33

(I)



MY 34

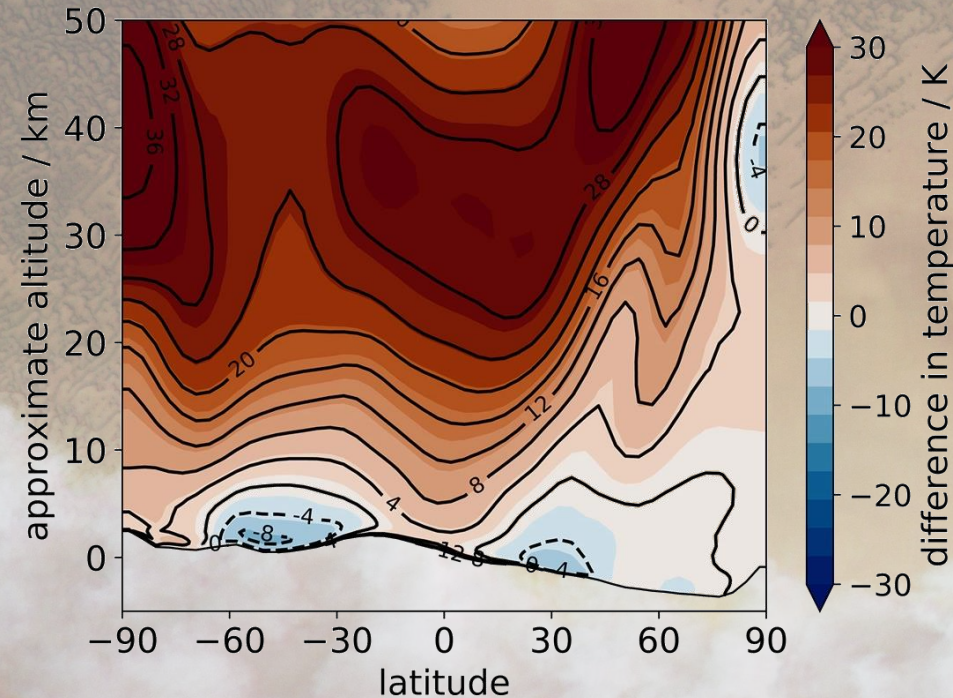
(II)



- Boosted meridional circulation...
- ...but limited diabatic (dust) heating

South

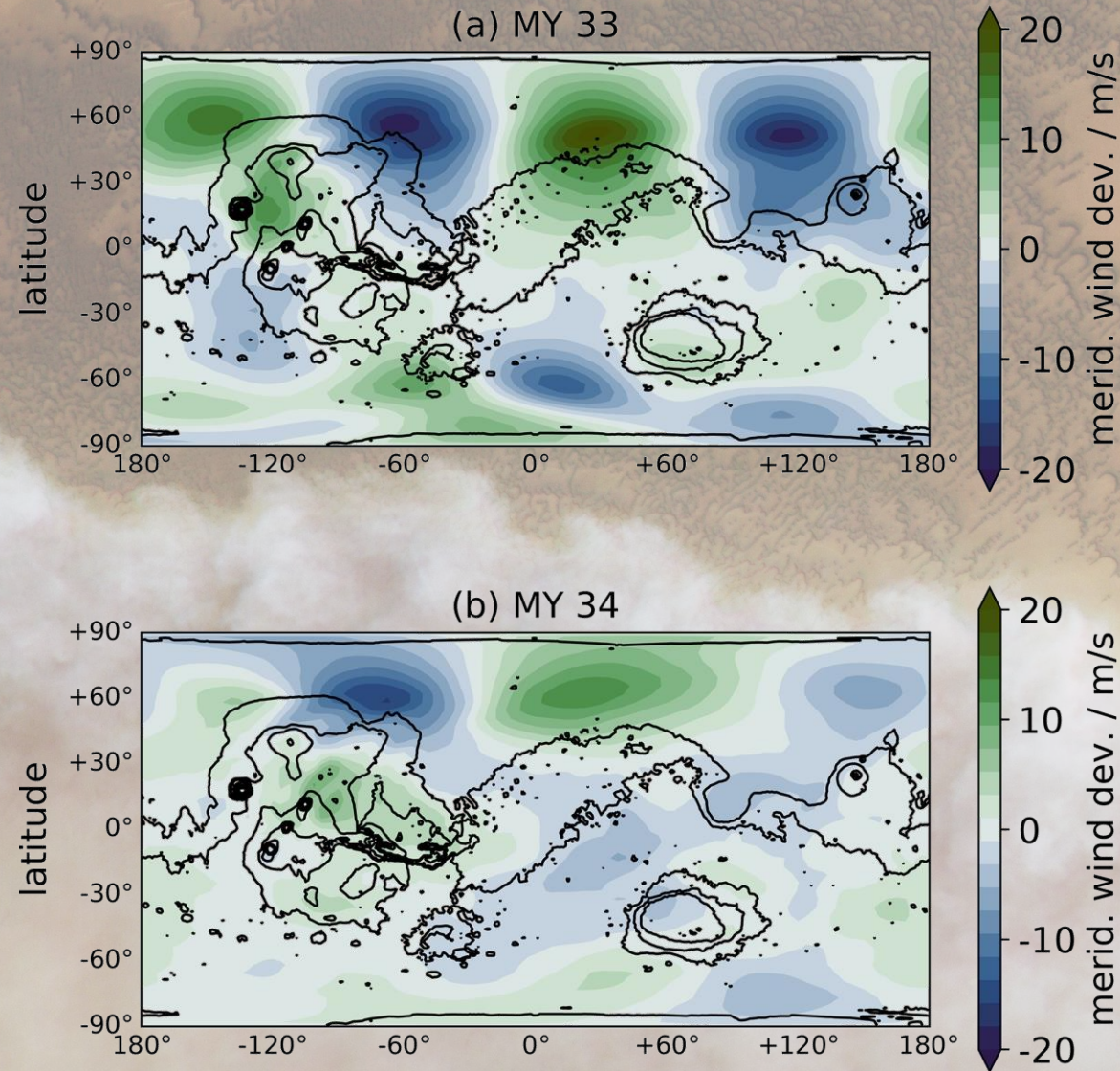
(e) MY 34 - MY 33



- High diabatic (dust heating) of the atmosphere
- Vortex already decaying (season)

What about shape?

- Plots of meridional wind deviation
- Reveals presence of stationary planetary waves: atmospheric waves with fixed position



- Stationary wave amplitude corresponds to decreased ellipticity of the polar vortices
- → Topography anchors polar vortex morphology